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### RESEARCH ARTICLE

#### OPTIMUM CROPPING PATTERN FOR FARMERS OF BIDAR DISTRICT, KARNATAKA.

**Dileep Kumar Kanna and Dr. M. N. Dandigi.**

1. Dileep Kumar Kanna, Civil Engineering Department, BKIT, Bhalki.585328 Bidar District, Karnataka, India.
2. Civil Engineering Department, P.D.A.College of Engineering, Kalburgi. 585101 Karnataka, India.

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#### Abstract

In the present study optimal solutions were found for net farm returns using Linear Programming model on the sample farmers of Bidar District. The LINGO 17.0 package was used to get the solutions. The sample was of 120 small and large farmers collected from 15 villages from five Tehsils. From each village eight farmers comprising of small and large farmers were selected. A total of EIGHT models were developed. They were classified as small farmers S1, S2, S3, S4 and large farmers L1, L2, L3, and L4. The results were compared with existing cropping pattern of small and large farmers. The model S1, small farmers with existing technology and restricted capital registered an increase of net returns per hectare by 27%, S2 small farmer with existing technology and relaxed capital returns increased by 34%, S3 small farmer with recommended technology and restricted capital, returns increased by 55%, S4 small farmer with recommended technology and relaxed capital, the returns increased by 65% per hectare. Similarly the net returns per hectare in case of large farmers L1, L2, L3, L4 increased by 47%, 65%, 49%, 76% respectively. The impact of credit on net farm returns in small farmers was Rs: 8322 and the same in large farmers was Rs: 615276. It was noted that credit played an important role in augmenting income of farmers; the credit required was directly related to farm size while credit on income, inversely related to farm size.

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#### Introduction:-

Agriculture plays an important role in shaping economy of our country. Its contribution to Gross Domestic Products (GDP) back in 1970 was about 44% has now reduced to 15% in 2018, thanks to other sectors such as services. Nevertheless, the importance of agriculture is not likely wane away due to concerns of food security, employment, rural poverty and availability of wages as goods (Vijay, 2012). The population in India is growing at a rate of 1.4% will soon surpass the population of China (in 2027). The country needs to produce approximately 320 million tonnes of food grains, 290 million tonnes of vegetables and fruits, 185 million tonnes of milk, 26 million tonnes of meat, eggs and fish and 23 million tonnes of edible oil by 2022. (Joshi and Kumar 2001). The increasing demand of agricultural products coupled with limited availability of farm resources needs a careful exploration of production

**Corresponding Author:-Dileep Kumar Kanna.**

Address:-Dileep Kumar Kanna, Civil Engineering Department, BKIT, Bhalki.585328 Bidar District. Karnataka India.

pattern, exploring possibilities of increasing efficiency of resources on various sizes of farms (Paroda and Praduman, 2000). The efficiency in agriculture is achieved by optimum utilization of resources.

Agriculture in India, due to increased farm input cost and dwindling profitability of farm products have made it a losing proposition. In view of this, it has become imperative that the available resources should be used judiciously and economically since more is efficiency higher will be the income. In present study, an attempt has been made to analyze possibilities and prospects of increasing net farm income by rational allocation of resources through optimum production pattern, the objective of which is to ascertain existing resource pattern, develop optimum combination of resources for different models and compare with existing pattern.

### Materials and Methods:-

The study was undertaken in Bidar District, Karnataka, which is an economically backward district. A total of 120 farmers were selected from five Tehsils, choosing three villages from each Tehsil. From these villages, four small farmers and four large farmers who have 2 hectares of land and more than 2 hectares of land respectively were selected. The study was conducted in the year 2018.



Fig 1:-Bidar Map

A linear programming model was used to explore the possibilities of optimizing net farm returns considering various crop activities.

Maximize  $Z = \sum_{j=1}^n C_j X_j$  where  $j = 1$  to  $n$  activities

Subjected to:

$\sum_{j=1}^n a_{ij} X_j \geq b_i$  ( $i = 1, \dots, k$ )

$\sum_{j=1}^n a_{ij} X_j \leq b_i$  ( $i = k+1, \dots, m$ )

$\sum_{j=1}^n a_{ij} X_j = b_i$  ( $i = m+1, \dots, v$ )

$X_j, b_i \geq 0$  (Non negatives constraints)

where,  $Z$  = Objective Function,

$C_j$  = price of  $j^{\text{th}}$  activity during kharif and rabi season,

$X_j$  = unit of  $j^{\text{th}}$  production activity during kharif and rabi,

$a_{ij}$  = amount of  $i^{\text{th}}$  resource required by  $j^{\text{th}}$  activity,

$b_i$  = quantity of  $i^{\text{th}}$  resource.

With above model four optimum plans (Models) were developed for farm situation and compared for income and employment.

1. Model-1: Restricted Capital and Existing Technology
2. Model -2: Unrestricted or Relaxed capital and Existing Technology
3. Model-3: Recommended technology with restricted capital
4. Model-4: Recommended Technology with unrestricted capital.

The resources available for farm production were considered as constraints which are taken as: a) Land: Irrigated and Dry Land (e.g. kharif irrigated, kharif dry land, rabi irrigated and rabi and rabi dry land) b) Human Labour: level of human labour for family and hired c) bullock labour: available labour during peak period d) Tractor power: some farmers are hiring tractor power and hence included in the model. e) Capital: it is the expenditure incurred on seeds, fertilizers, and farm yard manure (FYM), pesticides, irrigation and other inputs taken as cash restriction during the

plan period. The existing levels of all resources used on the farms were taken as maximum supply available on the farms. The constraints were set on FYM, N (Nitrogen), P (Phosphorous) and K (Potassium) for *kharif* and *rabi*. All crops grown on the farm were taken as real activity for present analysis.

The objective of the model was to maximize net annual returns on farm subject to resource constraints specified earlier. The net returns are obtained by deducting variable expenses from income. The variable costs were: the cost of seeds, manures, fertilizers, water, hired human labour and machine labour, pesticides, insecticides etc. The harvest prices were taken as output prices and the actual market prices of input at the time of application were taken as input prices.

### Results and Discussions:-

The discussion of results from investigation carried out is made through analyzing and comparing the existing cropping pattern with optimal cropping and also comparing net farm returns on different farm sizes.

**Table 1:-**Cropping pattern for small farmers under different optimal plans

Sl No	Particulars of Crop	Existing		S1		S2		S3		S4	
		Area (ha)	Percent								
1	Kharif Dry Land										
a	Soya bean	0.36	33.33	0.00	0.00	0.00	0.00	0.20	18.52	0.63	58.30
b	Black gram	0.28	25.92	0.00	0.00	0.00	0.00	0.78	72.22	0.20	18.52
c	Green gram	0.21	19.44	0.00	0.00	0.00	0.00	0.00	0.00	0.10	9.30
d	Red gram	0.24	22.22	1.08	100	1.08	100	0.10	0.09	0.15	13.88
	Fallow	--	--	--	--	---	--	----	---	---	---
	Total	1.08	100	1.08	100	1.08	100	1.08	100	1.08	100
2	Kharif Irrigated Land										
a	Sugarcane	0.33	64.70	0.18	36.07	0.41	80.40	0.00	0.00	0.00	0.00
b	Bengal gram	0.18	35.30	0.10	19.61	0.10	19.60	0.10	19.60	0.51	100
	Fallow	--	--	0.23	44.31	--	--	0.41	80.40	0.00	0.00
	Total	0.51	100	0.51	100	0.51	100	0.51	100	0.51	100
3	Rabi Dry Land										
	Fallow	1.08	100	1.08	100	1.08	100	1.08	100	1.08	100
	Total	1.08	100	1.08	100	1.08	100	1.08	100	1.08	100
4	Rabi Irrigated Land										
a	Sugarcane	0.33	64.70	0.18	35.29	0.41	80.40	0.00	0.00	0.00	0.00
b	Onion	0.18	35.30	0.33	64.71	0.10	19.60	0.51	100	0.51	100
	Total	0.51	100	0.51	100	0.51	100	0.51	--	0.51	---
5	Cropping Intensity (%)	132	----	118	----	132	----	106	--	132	--
6	Net farm returns for total cultivated area (Rs:)	74520	----	105196	----	113518	----	165332	--	21229	--
7	Net farm returns per Hectare cultivated area (Rs:)	46931	----	66161	----	71395	----	103982	--	133477	--

**Table 2:-Impact of Credit on Employment of Small and Large Farmers:**

Category	Existing Technology		Change Over	
	Model 1	Model 2	Absolute	Percent
<b>Small Farmers</b>				
Mandays	24.34	36.07	11.73	48.19
Womendays	42.16	57.96	15.84	37.47
Bullock days	6.26	8.97	2.71	43.29
Tractor Hours	1.93	1.48	-0.45	23.31
<b>Large Farmers</b>				
Mandays	76.97	249.9	172.93	224.67
Womendays	149.11	387.40	283.29	189.98
Bullock days	19.49	55.16	35.67	183.01
Tractor Hours	14.92	53.13	38.21	256.09

**Table 3:-Cropping Pattern for large farmers under different optimal plans**

Sl No	Particulars of Crop	Existing		L1		L2		L3		L4	
		Area (ha)	Percent								
1	Kharif Dry Land										
a	Soya bean	1.76	39.82	0.50	11.31	0.50	11.31	0.50	11.31	0.80	18.10
b	Black gram	0.90	20.36	0.40	9.00	0.40	9.00	2.40	5.30	3.42	77.37
c	Green gram	0.98	22.17	0.00	0.00	0.00	0.00	0.10	2.26	0.20	4.57
d	Red gram	0.79	17.29	0.15	3.40	3.52	79.63	0.00	0.00	0.00	0.00
	Fallow	--	--	3.37	76.24	--	--	---	---	---	--
	Total	4.42	100	4.42	100	4.42	100	4.42	100	4.42	100
2	Kharif Irrigated Land										
a	Sugarcane	0.50	30.54	0.10	0.05	0.10	0.00	1.00	6.00	0.10	6.00
b	Ginger	0.53	31.73	0.01	0.05	0.01	0.10	0.00	0.00	0.00	0.00
	Paddy	0.36	21.55	1.08	64.67	0.16	99.90	0.00	0.00	0.00	0.00
	Onion	0.14	8.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Tomato	0.18	10.78	0.00	0.00	0.00	0.00	0.00	0.00	0.10	6.00
	Chilies	0.18	10.78	0.00	0.00	0.00	0.00	0.38	22.75	1.47	88.00
	Fallow	--	--	0.48	28.74	--	0.00	1.19	71.25	--	---
	Total	1.67	100	1.67	100	1.67	100	1.67	100	1.67	100
3	Rabi Dry Land										
	Bengal gram	2.21	50.00	0.00	0.00	0.00	0.00	1.00	6.00	0.10	6.00
	Jowar	0.55	12.44	2.92	66.06	0.00	0.00	0.00	0.00	0.00	0.00
	Safflower	0.44	9.95	0.00	0.00	4.42	100	0.00	0.00	0.00	0.00
	Fallow	1.21	27.37	1.50	33.93	0.00	0.00	0.00	0.00	0.00	0.00
	Total	4.42	100	4.42	100	4.42	100	0.00	0.00	0.10	6.00
4	Rabi Irrigated Land										
a	Sugarcane	0.50	30.54	0.00	0.00	0.00	0.00	0.10	6.00	0.10	6.00
b	Ginger	0.30	17.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Chilies	0.18	10.78	0.00	0.00	0.00	0.00	0.38	22.75	1.47	88.00
	Wheat	0.34	20.36	0.16	93.40	1.56	93.41	0.00	0.00	0.10	6.00
	Fallow	0.34	20.36	0.11	6.60	0.11	6.60	1.19	71.26	0.00	0.00
	Total	1.67	100	0.67	100	1.67	100	1.67	100	1.67	100
5	Cropping Intensity	174	----	110	----	198		161	--	200	--

	(%)										
6	Net farm returns for total cultivated area (Rs:)	612076	----	1156481	----	1771757		1203872	--	2552051	--
7	Net farm returns per Hectare cultivated area (Rs:)	100497	----	189898	----	290929		197680	--	419056	--

**Table 4:-**Net Returns small and large farmers under different optimal models (Rs:)

Category	Existing	Model - 1	Change Over E-Plan	Model - 2	Change Over E-Plan	Model - 3	Change Over E-Plan	Model - 4	Change Over E-Plan
Small Farmers	74620	105196	30576	113518	38898	165332	90712	212229	137609
Large Farmers	612076	1156480	544405	1771757	1159681	1203872	591796	2552051	1939975

**Table 5:-**Impact of Credit on Net Farm Returns of Small and Large Farm in (Rs:)

Category	Existing Technology			Recommended Technology		
	Model 1	Model 2	Change Over Model 1	Model 3	Model 4	Change Over Model 3
Small Farmers	105196	113518	8322	165332	212229	46897
Large Farmers	1156481	1771757	615276	1203872	2552051	1348179

In optimal solution of small farmers S1, only one crop red gram emerged as 100 % cropped area in kharif dry land while in kharif irrigated land sugarcane, Bengal gram found their places. In *rabi* irrigated, onion (64.71%) emerged as dominant crop followed by sugarcane (35.29%). In S-2 model, under relaxed capital, the area of sugarcane increased to 80.40% due to availability of funds and Bengal gram again found its place due to local affinity. Interestingly there was no irrigated land left as fallow as was the case in model S1. The cropping intensity too increased to 132% from 118% compared to S1 and net farm returns also increased.

In model S3, under recommended technology with restricted capital black gram and soya bean emerged as optimal solutions in kharif dry land with 72% and 18% cropped area respectively while large amount of land 0.41, hectares (80%) was left fallow which may be due to restrictions imposed on capital and only 20% of area was occupied by Bengal gram in kharif irrigated land. The *rabi* dry land was again left fallow as was the case in existing cropping pattern. In *rabi* irrigated land only onion with 100% area found its place. Sugar cane which is an important cash crop in the region did not find its place. Due to this the cropping intensity reduced to 106% from 132% in existing pattern. The model however registered an increase in net return per hectare by 55%. In model S4, Bengal gram, soya bean and onion emerged as dominant crops followed by black gram and red gram. The model did not allocate land to any crop in *rabi* dry land. In *rabi* irrigated land onion occupied 100% area becoming only crop in that season. The cropping intensity increased slightly to 132% relative to model S3. The net increase in returns per hectare was 65%.

In optimal solutions of large farmers L1 from Table 2, large area of land (76.24%) was left fallow, may be due to restriction on funds in kharif dry land. Only soya bean and black gram found places with areas as 11.31% and 9% respectively. In kharif irrigated land paddy was dominant with 64.67% area followed by fallow land with 28.74%, sugarcane was little with only 0.05%. In *rabi* dry land surprisingly jowar was dominant with 66.06% followed by

again fallow land 33.93%. In *rabi* irrigated land wheat with 93.4% was dominant. In model L2 of large farmers with relaxed capital in kharif dry land red gram with 79.63% emerged as dominant crop followed by soya bean and black gram. In kharif irrigated land paddy emerged as dominant with 99.9% while in *rabi* dry land only one crop safflower found place and in *rabi* irrigated wheat with 93.41% and fallow land with 6.6% were formed as optimal solutions. The net cropping intensity was found to be 198% which is due to relaxed capital. Paddy and wheat which are food crops have emerged as dominant crops in both seasons.

In model L3, black gram (54.3%) and soya bean (11.3%) emerged as feasible crops in kharif dry land followed by green gram 2.26%. Large amount of land 32% was left as fallow. This could be due to scarcity of funds faced by the farmer. In kharif irrigated land chilies with 22.75% and sugar cane with 6% found their places while 71% of land was again left fallow. This is not desirable as country like ours irrigated land cannot go uncultivated. In *rabi* dry land only one crop jowar found its place with 100% area. While in *rabi* irrigated land sugar cane and chilies continued their occupation and no new crop emerged. Again 71% of the land was left fallow. In model L4, black gram, soya bean emerged as optimal solutions in kharif dry land followed by green gram while in kharif irrigated land the model has utilized entire irrigated area giving 88% to chilies and 6% each to sugar cane and tomato. In *rabi* dry land jowar occupied 97% while Bengal gram occupied only 3%. In *rabi* irrigated land chilies continued its occupation from previous season and so was with sugar cane. Wheat found its place with 6% area in this model. The cropping intensity increased to 200% for the first time in all three models. Also the increase in returns were up, to 76%.

The net increases in returns in small farmers in model 1 compared to existing is Rs:30576 (29%) in Table 4 and in case of model 2 it is Rs:38898 (24%) and the net increase in recommended technology was Rs:90712 (54.8%) for S3 and for S4 the increase was Rs:137609 (64%). Similarly in case large farmers in model 1 under restricted capital the increase in net returns compared to existing pattern was Rs:544405 (47%) and in case of model 2 the increase was Rs:115968 (65%). The increase in the return under recommended technology in model L3 was Rs:591796 (49%). Similarly the net increase in model L4 was Rs: 1939975 (76%). The impact of credit on net farm returns from Table 5 for small farmers is Rs: 8322 and for large farmers it is Rs: 61527. The employment generated by the model is not very encouraging. In case of small farmers in model S1 and S2 as family labour was sufficient and no hired labour was required. But in case of large farmers under relaxed capital the employment was generated in case of tractor hours and women labour. The Table 2 gives impact of credit on employment which is significant in case of large farmers where an increase of tractor hours and Man days of 256 and 224 percent respectively.

### Conclusion:-

The study has brought out that there is a huge scope for increasing the net farm returns on both dry land and irrigated farm lands through reorganization of resources. The results also revealed that credit played an important role in increasing the income through reallocation of resources. Hence the farmers in the area be educated regarding the benefits of optimization techniques and they also be provided with short term credit facilities so that their net farm returns are increased. It was noted that credit required was directly related to farm size while credit on income, inversely related to farm size.

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